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# UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	82225.P1423D	Total Pages (all documents)
First Named Inventor or Application Identifier Lam		
<b>BOARD LEVEL DECAPSULATOR</b>		
Express Mail Label No.	EM560888851us	

**APPLICATION ELEMENTS**

See MPEP chapter 600 concerning utility patent application contents.

Assistant Commissioner for Patents  
Box Patent Application  
Washington, DC 20231

- |   |   |
|---|---|
| <p>1. <input checked="" type="checkbox"/> *Fee Transmittal Form<br/>(Submit an original, and a duplicate for fee processing)</p> <p>2. <input checked="" type="checkbox"/> Specification Total Pages <input type="text" value="18"/></p> <ul style="list-style-type: none"> <li>- Descriptive Title of the Invention</li> <li>- Cross References to Related Applications</li> <li>- Statement Regarding Fed sponsored R&amp;D</li> <li>- Reference to Microfiche Appendix</li> <li>- Background of the Invention</li> <li>- Brief Summary of the Invention</li> <li>- Brief Description of the Drawings (if filed)</li> <li>- Detailed Description</li> <li>- Claims</li> <li>- Abstract of the Disclosure</li> </ul> <p>3. <input checked="" type="checkbox"/> Drawing(s) (35 USC 113) Total Sheets <input type="text" value="2"/></p> <p>4. <input checked="" type="checkbox"/> Oath of Declaration Total Pages <input type="text" value="2"/></p> <p>a. <input type="checkbox"/> Newly executed (original copy)</p> <p>b. <input checked="" type="checkbox"/> Copy from prior application (37 CFR 1.63(d))<br/>(for continuation/divisional with Box 17 completed)</p> | <p>5. <input type="checkbox"/> Microfiche Computer Program (Appendix)</p> <p>6. <input type="checkbox"/> Nucleotide &amp;/or Amino Acid Sequence Submission<br/>(if applicable, all necessary)</p> <p>a. <input type="checkbox"/> Computer Readable Copy</p> <p>b. <input type="checkbox"/> Paper Copy (identical to computer copy)</p> <p>c. <input type="checkbox"/> Statement verifying identity of above copies</p> |
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**ACCOMPANYING APPLICATION PARTS**

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|---|--|
| <p>7. <input checked="" type="checkbox"/> Assignment Papers (cover sheet &amp; document(s))</p> <p>8. <input type="checkbox"/> 37 CFR3.73(b) Statement <input type="checkbox"/> Power of Attorney<br/>(when there is an assignee)</p> <p>9. <input type="checkbox"/> English Translation Document (if applicable)</p> <p>10. <input type="checkbox"/> Information Disclosure <input type="checkbox"/> Copies of IDS<br/>Statement (IDS)/PTO-1449 Citations</p>                            |  |
| <p>11. <input checked="" type="checkbox"/> Preliminary Amendment</p> <p>12. <input checked="" type="checkbox"/> Return Receipt Postcard (MPEP 503)</p> <p>13. <input type="checkbox"/> *Small Entity <input type="checkbox"/> Statement filed in prior app<br/>Statement(s) Status still proper and desired</p> <p>14. <input type="checkbox"/> Certified Copy of Priority Document(s)<br/>(if foreign priority is claimed)</p> <p>15. <input type="checkbox"/> Other:<br/><br/><br/></p> |  |

16. If a CONTINUING APPLICATION, check appropriate box and supply the requisite information below &amp; in a preliminary amendment:

Continuation  Divisional  Continuation-in-part (CIP) of prior application no: 08/740,380

Prior application information: Examiner: A. POWELL Group/Art Unit: 1763

**For Continuation or Divisional Apps only:** The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 4b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

**17. CORRESPONDENCE ADDRESS**

NAME: Blakely, Sokoloff, Taylor & Zafman LLP	STATE: California	ZIP: 90025-1026
ADDRESS: 12400 Wilshire Boulevard, 7th Floor	TELEPHONE: (310)207-3800	FAX: (310)820-5988
CITY: Los Angeles		
COUNTRY: USA		

Name (Print/Type)	ERIC S. HYMAN, ESQ.		
Signature			
	Date	C/18/95	

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**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re Application for: )  
Lam )  
For: **BOARD LEVEL DECAPSULATOR** )  
)

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**PRELIMINARY AMENDMENT**

Honorable Commissioner of Patents  
and Trademarks  
Washington, D.C. 20231

Sir:

Please amend the above-identified application as follows:

**IN THE SPECIFICATION**

After the title, please insert -- This is a divisional of application Serial No. 08/740,380 filed  
October 29, 1996 --.

**IN THE CLAIMS**

Please cancel claims 1-8.

In Claim 10, line 1, please change "7" to -9--.

Please add the following claims:

- 1        --11. The method as recited in claim 9, further comprising the step of controlling a flow of  
2        the decapsulation fluid through a pair of tubes that couple an extender to said injection head using a  
3        corresponding pair of valves.
  
- 1        12. The method as recited in claim 9, further comprising the step of plugging a stub that  
2        supports the printed circuit board into a substrate of said tray.
  
- 1        13. A method for decapsulating an integrated circuit package that is mounted to a first  
2        surface of a printed circuit board, the printed circuit board having a second surface located below  
3        the first surface of the printed circuit board, comprising the step of:

4 spraying a decapsulation fluid onto the integrated circuit package via an injection head  
5 clamped to the integrated circuit package, said injection head having a nozzle disposed above the  
6 integrated circuit package that is in fluid communication with an inlet port of said injection head,  
7 and a return port that is in fluid communication with an outlet port of said injection head.

1 14. The method as recited in claim 13, further comprising the step of controlling a flow  
2 of the decapsulation fluid through a pair of tubes that couple an extender to said injection head  
3 using a corresponding pair of valves.

1 15. The method as recited in claim 13, further comprising the step of plugging a stub  
2 that supports the printed circuit board into a substrate.

1 16. The method as recited in Claim 13 further comprising the step of forming a seal  
2 between said injection head and said integrated circuit package. --

REMARKS

Entry of the foregoing amendments prior to the initial examination of the above-captioned application is requested.

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN

  
Eric S. Hyman  
Reg. No. 30,139

Dated: June 17, 1999

12400 Wilshire Boulevard  
Seventh Floor  
Los Angeles, California 90025  
(310) 207-3800

Our File No.: 082225.P1423

**UNITED STATES PATENT APPLICATION**

**FOR**

**BOARD LEVEL DECAPSULATOR**

**INVENTOR: Chung Lam**

**PREPARED BY:**

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN  
12400 Wilshire Blvd., 7th Floor  
Los Angeles, CA 90025-1026  
(310) 207-3800

## **BACKGROUND OF THE INVENTION**

### **1. FIELD OF THE INVENTION**

5       The present invention relates to a system for decapsulating an integrated circuit package that is mounted to a printed circuit board.

### **2. DESCRIPTION OF RELATED ART**

10

Integrated circuits (ICs) typically contain a plurality of surface pads that are connected to the circuit of the IC. After fabrication the IC can be tested by placing probe pins of a device tester onto 15 the surface pads. Integrated circuits are typically assembled into a package that is soldered to a printed circuit board. Some packages are constructed from a molded plastic material that encapsulates the integrated circuit. The integrated circuit becomes 20 inaccessible to external test equipment after the plastic material is molded onto the IC. It is sometimes desirable to test the integrated circuit after the plastic is molded around the IC.

The integrated circuit can be exposed by decapsulating the plastic package within a device level decapsulation system (DLDS). The decapsulation system exposes a portion of the package to an etchant that 5 removes the plastic material without attacking the underlying integrated circuit. The etchant is applied to the package until the surface pads of the IC are exposed to the ambient. Probe pins can then be placed onto the surface pads to test the integrated circuit.

10 It is sometimes desirable to test an integrated circuit after the IC is mounted to a printed circuit board. Debugging an individual integrated circuit after assembly to a printed circuit board presently requires the removal of the package from the board.

15 The package is typically removed by applying heat to the assembly to reflow the solder joints. Reflowing and removing the package may damage the package leads, particularly packages which have fine high pitch lead counts. The reflow process also reduces the integrity 20 of the board.

It is also desirable to test integrated circuits while the IC packages are still mounted to the printed circuit board. Final assembly tests are particularly desirable for high speed devices that are sensitive to

the impedance of the circuit board. The device level decapsulation systems of the prior cannot expose the IC while the package is mounted to the printed circuit board. It is therefore desirable to provide a system 5 that can decapsulate an integrated circuit package while the package is mounted to a printed circuit board.

## SUMMARY OF THE INVENTION

The present invention is a system that decapsulates an integrated circuit package while the 5 package is mounted to a printed circuit board. The system includes a tray that supports a printed circuit board which has at least one integrated circuit package mounted to the board. Mounted to the tray is a clamp which clamps an injection head to the top of the 10 package. The injection head is coupled to a source of decapsulation fluid which is sprayed onto the package. The decapsulation fluid is circulated across the package to remove the package material and expose the underlying integrated circuit. The injection head has 15 a gasket that is pressed onto the package to prevent the fluid from leaking onto the printed circuit board. After the plastic is decapsulated the head can be removed from the package so that the integrated circuit can be tested while the circuit is connected to the 20 printed circuit board.

### **BRIEF DESCRIPTION OF THE DRAWINGS**

The objects and advantages of the present invention will become more readily apparent to those ordinarily skilled in the art after reviewing the following detailed description and accompanying drawings, wherein:

Figure 1 is a schematic of a decapsulation system of the present invention;

Figures 2a-b are cross-sectional views of an injection head of the system;

Figures 3a-b are cross-sectional views of an extender of the system.

## DETAILED DESCRIPTION OF THE INVENTION

Referring to the drawings more particularly by reference numbers, Figure 1 shows a system 10 for decapsulating an integrated circuit package 12 that is mounted to a printed circuit board 14. The system 10 decapsulates the package 12 by removing a top portion of the package material to expose an underlying integrated circuit (IC) 16. Exposing the integrated circuit 16 allows the probe pins (not shown) of a device tester to be placed onto the IC 16 while the package 12 is still mounted to the board 14.

The system 10 includes a tray 18 that supports the printed circuit board 14. The system 10 contains a clamp 20 that is mounted to a substrate 22 of the tray 18. The clamp 20 has a leg portion 24 which supports a portion of the printed circuit board 14. The printed circuit board 14 is also supported by a plurality of stubs 26 that are plugged into corresponding apertures 28 of the substrate 22. The top surface of the substrate 22 preferably has a plurality of apertures 28 that allow the stubs 26 to be plugged into any location within the tray 18. The plugs 26 can be moved within

the tray 18 to compensate for printed circuit boards 14 that have different outer dimensions.

The clamp 20 has a screw 30 that presses an injection head 32 onto the top surface of the 5 integrated circuit package 12. The injection head 32 sprays a decapsulation fluid onto the package 12. The decapsulation fluid removes the plastic material to expose the underlying integrated circuit 16. The head 32 has a gasket 34 that is pressed into the package 12. 10 The gasket 34 is typically constructed from a material such as fluoric rubber that is inert to the decapsulation fluid. The gasket 34 prevents the decapsulation fluid from leaking onto the printed circuit board 14. The gasket 34 also allows the 15 decapsulation fluid to be recaptured for further use. The dimensions and shape of the gasket 34 define the size and shape of the opening in the package 12.

The system 10 includes a decapsulation supply unit 36 which provides decapsulation fluid to 20 the injection head 32. The unit 36 includes a pump 38 that circulates the fluid into the injection head 32 and across the package 12. The unit 36 also has a reservoir 40 and a valve 42 that controls the flow of fluid into the injection head 32. The valve 42 may be

actuated by a controller (not shown) that can be programmed through a control panel. By way of example, the operator can set a start and stop time to decapsulate the package 12. The supply unit 36 may be 5 a product sold by Nippon Scientific Co. Ltd. under the designation Plastic Mold Decapsulation System PA102. The Nippon product is typically used to decapsulate individual integrated circuit packages that are not mounted to a printed circuit board 14.

10 To utilize the existing Nippon product the system 10 has an extender 44 that is mounted to the nozzle 46 of the unit 36. The extender 44 allows the injection head 32 to be coupled to the unit nozzle by a pair of tubes 48 which carry the decapsulation fluid. The 15 tubes 48 are typically constructed from TEFLON material which is inert to the decapsulation fluid. The system 10 preferably contains a pair of stop cock valves 50 that allow an operator to terminate the flow of fluid into the injection head 32. The tubes 48 are routed 20 through a plastic shield 52 which encloses the injection head 32 and the circuit board 14.

Figures 2a-b show a preferred embodiment of an injection head 32. The head 32 includes a nozzle 54 that is in fluid communication with an inlet port 56.

The nozzle 54 sprays the decapsulation fluid onto the package 12. The head 32 also has a pair of return ports 58 coupled to an outlet port 60. The inlet 56 and outlet 60 ports are coupled to the extender 44 by tubes 48. The injection head 32 is preferably constructed from a material such as high density polyethylene (HDPE) that is inert to the decapsulation fluid.

Figures 3a-b show a preferred embodiment of an extender 44 mounted to the nozzle interface 46 of the unit 36. The extender 44 has an intake port 62 that is in fluid communication with an outlet port 64, and aligned with a nozzle 66 of the unit 36. The intake port 62 and outlet port 64 direct the fluid into the injection head 32. The extender 44 also contains a pair of exhaust ports 68 that are in fluid communication with an inlet port 70, and aligned with a pair of return ports 72 of the unit 36. The exhaust 68 and inlet 70 ports direct the fluid from the injection head 32 to the unit 36. A seal 74 is preferably located between the nozzle 46 and the extender 44. The extender 44 is preferably constructed from an HDPE material.

In operation, a printed circuit board 14 and accompanying integrated circuit package 12 are placed onto the clamp leg 24 and stubs 26 of the tray 18. The screw 30 is manipulated to provide a clearance for the 5 insertion of the injection head 32 onto the package 12. The screw 30 is then turned to secure the head 32 to the package 12. The valves 42 and 50 are opened to allow the decapsulation fluid to flow onto the package 12.

10       The fluid circulates through the head 32 until the package 12 is decapsulated and the integrated circuit 16 is exposed. The valve 42 is then closed to terminate the flow of fluid. The intake valve is typically closed first to evacuate the fluid from the 15 head 32. The screw 30 is turned so that the head 32 can be detached from the package 12. The board is then removed so that the integrated circuit 16 can be tested.

20       While certain exemplary embodiments have been described and shown in the accompanying drawings, it is to be understood that such embodiments are merely illustrative of and not restrictive on the broad invention, and that this invention not be limited to the specific constructions and arrangements shown and

described, since various other modifications may occur to those ordinarily skilled in the art.

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What is claimed is:

1        1. A system for decapsulating an integrated  
2 circuit package that is mounted to a printed circuit  
3 board, comprising:

4              a source of a decapsulation fluid;  
5              a tray that supports the printed circuit board;  
6              an injection head that is located adjacent to the  
7 integrated circuit package, said injection head has a  
8 nozzle and a return port that are coupled to said  
9 source of decapsulation fluid to introduce the  
10 decapsulation fluid to the integrated circuit package;  
11 and,

12              a gasket that seals said injection head to the  
13 integrated circuit package.

1        2. The system as recited in claim 1, further  
2 comprising a clamp that clamps said injection head onto  
3 the integrated circuit package.

1        3. The system as recited in claim 1, wherein said  
2 source of decapsulation fluid includes an extender that  
3 is coupled to a nozzle that provides the decapsulation  
4 fluid.

1       4. The system as recited in claim 3, further  
2 comprising a pair of tubes that couple said extender to  
3 said injection head.

1       5. The system as recited in claim 4, further  
2 comprising a pair of valves that control a flow of the  
3 decapsulation fluid through said tubes.

1       6. The system as recited in claim 1, wherein said  
2 tray includes a stub that supports the printed circuit  
3 board and which is plugged into a substrate of said  
4 tray.

1       7. A system for decapsulating an integrated  
2 circuit package that is mounted to a printed circuit  
3 board, comprising:

4           a substrate;

5           a clamp that is mounted to said substrate, said  
6 clamp having a leg portion that supports the printed  
7 circuit board;

8           a stub that is plugged into said substrate and  
9 which supports the printed circuit board;

10        a decapsulation fluid unit which has a nozzle that  
11   provides a decapsulation fluid, and a return port that  
12   receives the decapsulation fluid;

13        an extender that has an intake port that is in  
14   fluid communication with an outlet port of said  
15   extender and said nozzle of said decapsulation fluid  
16   unit, and an exhaust port that is in fluid  
17   communication with an inlet port of said extender and  
18   said return port of said decapsulation fluid unit;

19        an injection head that is clamped to the  
20   integrated circuit package by said clamp, said  
21   injection head has a nozzle that is in fluid  
22   communication with an inlet port of said injection  
23   head, and a return port that is in fluid communication  
24   with an outlet port of said injection head;

25        a first tube that couples said outlet port of said  
26   extender with said inlet port of said injection head;

27        a second tube that couples said inlet port of said  
28   extender with said outlet port of said injection head;  
29   and,

30        a gasket that seals said injection head to the  
31   integrated circuit package.

1       8. The system as recited in claim 4, further  
2 comprising a pair of valves that control a flow of the  
3 decapsulation fluid through said tubes.

1       9. A method for decapsulating an integrated  
2 circuit package that is mounted to a printed circuit  
3 board, comprising the steps of:

- 4           a) providing an injection head that sprays a  
5 decapsulation fluid;
- 6           b) placing the printed circuit board onto a tray;
- 7           c) clamping said injection head onto the  
8 integrated circuit package; and,
- 9           d) spraying the decapsulation fluid onto the  
10 integrated circuit package.

1       10. The method as recited in claim 7, further  
2 comprising the step of moving a stub that is plugged  
3 into said tray and which supports the printed circuit  
4 board before the printed circuit board is placed onto  
5 said tray.

## ABSTRACT OF THE DISCLOSURE

A system that decapsulates an integrated circuit package while the package is mounted to a printed circuit board. The system includes a tray that supports a printed circuit board which has at least one integrated circuit package mounted to the board.

5 Mounted to the tray is a clamp which clamps an injection head to the top of the package. The

10 injection head is coupled to a source of decapsulation fluid which is sprayed onto the package. The decapsulation fluid is circulated across the package to remove the package material and expose the underlying integrated circuit. The injection head has a gasket

15 that is pressed onto the package to prevent the fluid from leaking onto the printed circuit board. After the plastic is decapsulated the head can be removed from the package so that the integrated circuit can be tested while the circuit is connected to the printed

20 circuit board.

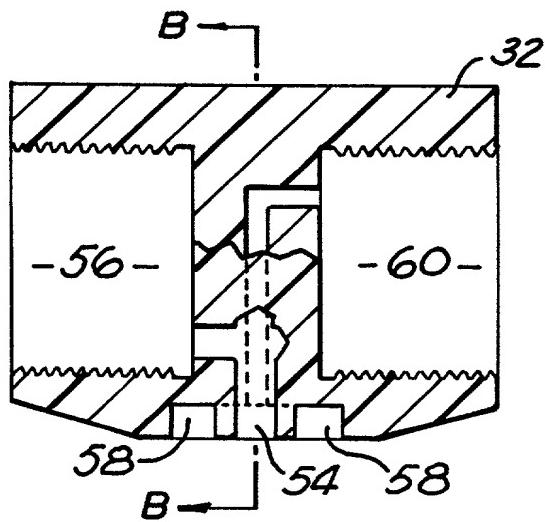


FIG. 2A

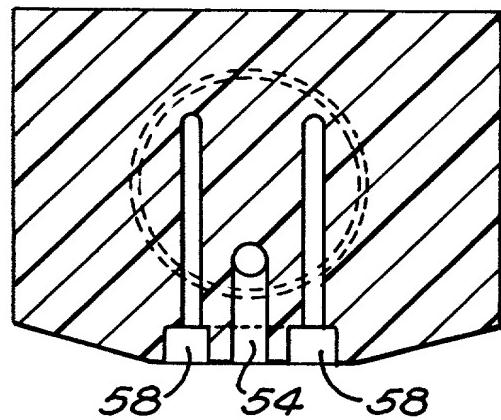


FIG. 2B

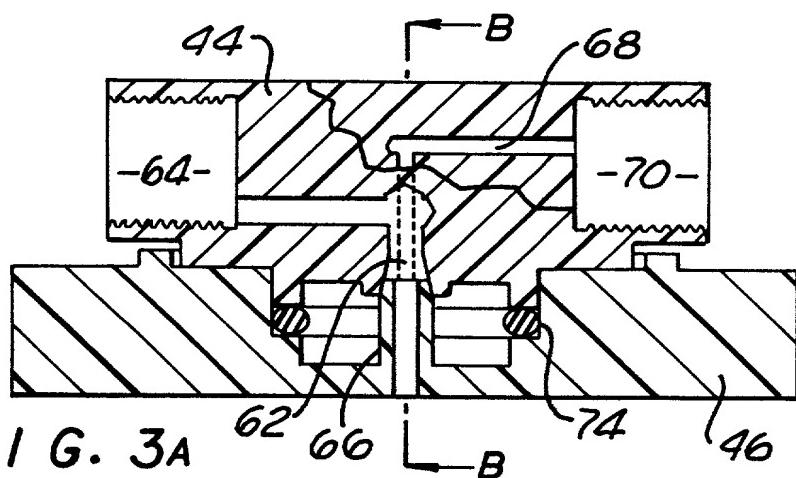


FIG. 3A

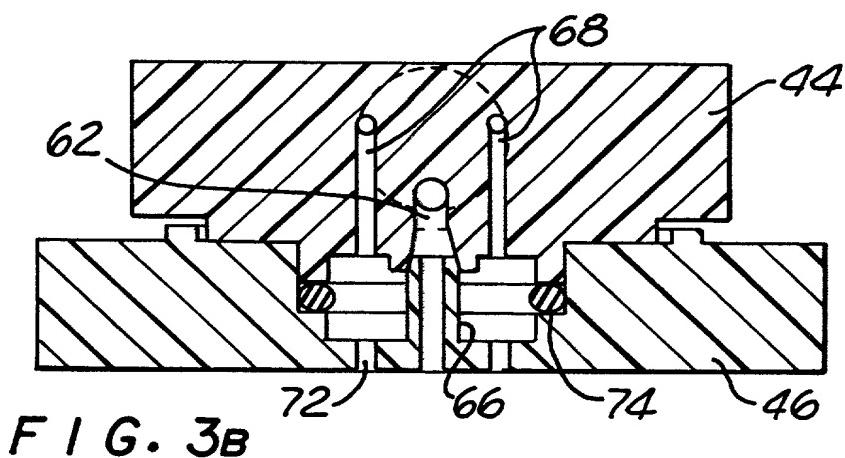


FIG. 3B

100% of the time, the system is in a state where the pressure in the chamber is equal to the atmospheric pressure. This is indicated by the absence of any pressure differential across the diaphragm.

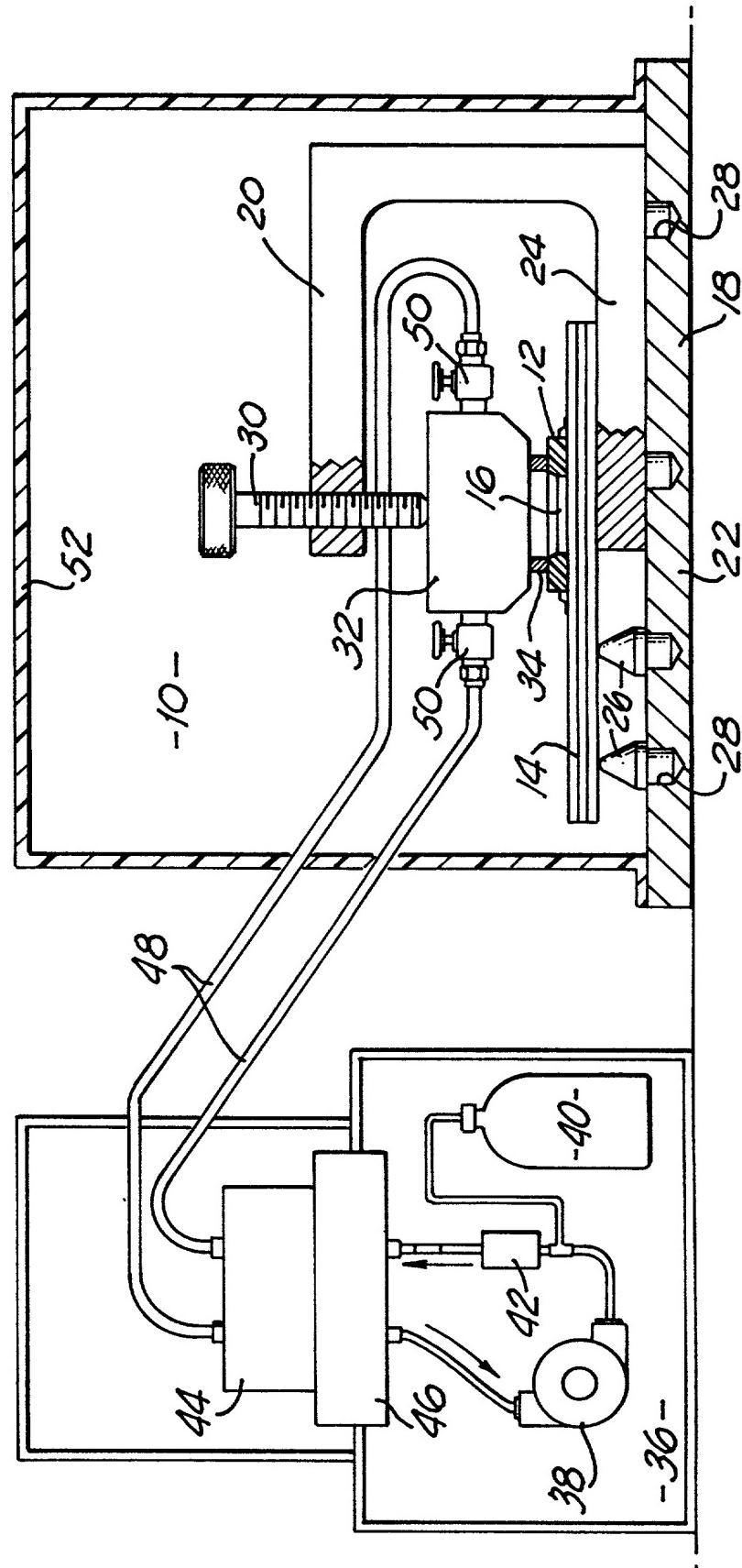


FIG. 1

## **DECLARATION AND POWER OF ATTORNEY**

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below, next to my name,

I believe I am the original, first and sole inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled:

### **BOARD LEVEL DECAPSULATOR**

the specification of which

XXXXXX is attached hereto.  
\_\_\_\_\_  
was filed on \_\_\_\_\_ as Application No. \_\_\_\_\_  
and was amended on \_\_\_\_\_ (if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above. I do not know and do not believe that the same was ever known or used in the United States of America before my invention thereof, or patented or described in any printed publication in any country before my invention thereof or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, and that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months prior to this application.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, Section 1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119, of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

#### Prior Foreign Application(s) Priority Claimed

Number	Country	Day/Month/Year Filed	Yes	No
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I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, Section 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application No.)	(Filing Date)	(Status -- patented, pending, abandoned)
-------------------	---------------	---

I hereby appoint Aloysius T. C. AuYeung, Reg. No. 35,432; William Thomas Babbitt, Reg. No. 39,591; Kent D. Baker, Reg. No. 38,822; Jordan Michael Becker, Reg. No. 39,602; Bradley J. Bereznak, Reg. No. 33,474; Michael A. Bernadicou, Reg. No. 35,934; Roger W. Blakely, Jr., Reg. No. 25,831; Gregory D. Caldwell, Reg. No. 39,926; Kent M. Chen, Reg. No. 39,630; Lawrence M. Cho, Reg. No. 39,942; Thomas M. Coester, Reg. No. P39,637; Roland B. Cortes, Reg. No. 39,152; William Donald Davis, Reg. No. 38,428; Daniel M. De Vos, Reg. No. 37,813; Karen L. Feisthamel, Reg. No. 40,264; David R. Halvorson, Reg. No. 33,395; Eric Ho, Reg. No. P39,711; George W Hoover II, Reg. No. 32,992; Eric S. Hyman, Reg. No. 30,139; Jeffrey D. Jacobs, Reg. No. 40,029; Dag H. Johansen, Reg. No. 36,172; Stephen L. King, Reg. No. 19,180; Dolly M. Lee, Reg. No. 39,742; Daniel C. Mallory, Reg. No. 33,532; Michael J. Mallie, Reg. No. 36,591; Kimberley G. Nobles, Reg. No. 38,255; Ronald W. Reagin, Reg. No. 20,340; James H. Salter, Reg. No. 35,668; William W. Schaal, Reg. No. 39,018; James C. Scheller, Reg. No. 31,195; Maria McCormack Sobrino, Reg. No. 31,639; Stanley W. Sokoloff, Reg. No. 25,128; Allan T. Sponseller, Reg. No. 38,318; Steven R. Sponseller, Reg. No. 39,384; David R. Stevens, Reg. No. 38,626; Edwin H. Taylor, Reg. No. 25,129; Lester J. Vincent, Reg. No. 31,460; John Patrick Ward, Reg. No. 40,216; Ben J. Yorks, Reg. No. 33,609; and Norman Zafman, Reg. No. 26,250; my attorneys; and Gary B. Goates, Reg. No. 35,159; Michael Anthony DeSanctis, Reg. No. 39,957; Charles E. Shemwell, Reg. No. 40,171; Edwin A. Sloane, Reg. No. 34,728; and Judith A. Szepesi, Reg. No. 39,393; my patent agents, of BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN, with offices located at 12400 Wilshire Boulevard, 7th Floor, Los Angeles, California 90025, telephone (310) 207-3800, and Erwin Basinski, Reg. No. 34,773; Timothy J. Crean, Reg. No. 37,116; Kang S. Lim, Reg. No. 37,491; Philip J. McKay, Reg. No. 38,966; Lee Patch, Reg. No. 30,095; Matthew C. Rainey, Reg. No. 32,291; and Leland Z. Wiesner, Reg. No. 39,424 of Sun Microsystems, Inc., with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected herewith.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of Sole/First Inventor: Chung Lam

Inventor's Signature

Chung Lam

Date 10/24 - 1996

Residence

34779 Bowie Common

Citizenship U.S.A.

Fremont, California 94555

P.O. Address

34779 Bowie Common

Fremont, California 94555

BJY/dms  
071196